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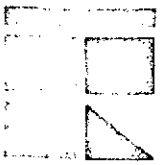
ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.



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27 September 1973

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attention: Mr. James R. Greaves
ERTS Scientific Monitor, Code 651

Subject: ERTS-A Investigation No. SR126: Evaluate the Application of ERTS-A Data for Detecting and Mapping Sea Ice

Principal Investigator: James C. Barnes, PR525

Gentlemen:

This is the fifth bimonthly Type I Progress Report describing work performed by Environmental Research & Technology, Inc. (ERT), for the National Aeronautics and Space Administration under Contract No. NAS 5-21802. This report covers the period from 10 July to 10 September 1973.

The purpose of this investigation is to evaluate the application of imagery from the ERTS-A RBV and MSS sensors for surveillance of sea ice. The objectives are: to determine the spectral interval most suitable for ice survey; to measure the scale and types of ice features that can be detected; and to develop simplified interpretive techniques for differentiating ice from cloud and for mapping ice features. The results will enable the maximum use of data from ERTS and future spacecraft systems for operational ship routing, compilation of ice charts, and scientific research.

A. ACCOMPLISHMENTS DURING REPORTING PERIOD

During the period of performance since the previous progress report (Type II report, July 1973), the analysis of the ERTS data sample from this spring and summer has continued. Mosaics comprising several scenes have been prepared and gridded for selected passes viewing the Beaufort Sea, M'Clure Strait, and Amundsen Gulf areas. In general, the passes selected for analysis are those with a minimum amount of cloud cover and which provide repetitive coverage over the same area; thus, temporal changes in ice features can be mapped.

The analysis of ERTS imagery covering the area of the Bering Sea Experiment (BESEX) has also continued. The aircraft photography requested from three NASA CV-990 flights (Flight No. 9, 28 February-1 March 1973; Flight No. 12, 5 March 1973; and Flight No. 13, 7 March 1973) has been received from NASA/GSFC. Investigation of the identifiable ice types and size of features that can be mapped in the corresponding ERTS imagery (enlarged to a scale of 1:500,000) is currently in progress. Some of the identifiable features are described in the following paragraphs.

Four aerial photographs of inbound Flight No. 9, 0308Z to 0311Z, 1 March 1973, cover the area northeast of Nunivak Island in Baird Inlet, which ERTS viewed at 2144Z, 28 February 1973 (ID No. 1220-21440). The earliest photograph of the sequence (extreme left) shows a portion of a polynya separating fast ice (first year, snow covered) from young ice (grey). Also, a narrow band of young ice (grey) approximately 350 ft to 1 n.mi. wide is visible along the edge of the snow covered fast ice. Each of these features is observed in the enlarged ERTS imagery. The three remaining aerial photographs show only solid fast ice (snow-covered) and the coastline of Alaska.

Two segments of Flight No. 12, 2117Z to 2130Z, 5 March 1973, show excellent agreement with the ERTS imagery of 6 March 1973, 2217Z (ID No. 1226-22171 and 22174). One segment of six aerial photographs for the region just north of St. Lawrence Island shows numerous multiyear floes (vast, big, medium and small) embedded in grey and grey-white ice, as well as several fractures. Twenty-four hours later these same vast, big, and medium multiyear floes embedded in grey and grey-white ice can be identified in the ERTS enlargement. The small floes, however, are not as readily detected due to the overall brightness variations existing within the grey and grey-white ice. The fractures (approximately 200 to 300 feet wide) seen in the photography are not visible in the ERTS imagery, indicating that they may have either closed or refrozen during the 24-hour interval. A fracture which did not appear in a vast floe in the aerial photography is visible in the ERTS image.

Another segment of five aerial photographs shows young fast ice (grey and grey-white) 1/8 to 3/4 of a nautical mile in width along a portion of the west coast of St. Lawrence Island. Pack ice off the southwest coast comprised of young (grey) ice is also visible. These same features are readily observed in the corresponding ERTS image.

B. PLANS FOR NEXT REPORTING PERIOD

During the next reporting period the investigation of the application of ERTS data for mapping arctic sea ice will be concluded. Analysis of the data sample from the 1973 spring and summer seasons, including measurements of the scales of identifiable ice features, the movements of ice, and the ice deformation, will be completed. The comparative analysis of ERTS imagery and aerial photographs for the Bering Sea will be completed. All analysis procedures, results, and conclusions will be documented in a final report to be submitted at the end of the reporting period.

C. PROBLEMS

No problems to impede the progress of the investigation are anticipated.

D. ERTS IMAGE DESCRIPTION FORMS

Image Descriptor Forms are attached to this progress report.

E. FUNDS

It is anticipated that the remaining funds will be adequate for successful completion of the investigation.

Very truly yours,

James C. Barnes

James C. Barnes
Principal Investigator

JCB:jm

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

NDPF USE ONLY
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ID

DATE 26 September 1973

PRINCIPAL INVESTIGATOR James C. Barnes

GSFC PR525

ORGANIZATION Environmental Research & Technology, Inc.

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	Fast Ice	Pack Ice	Leads	
1244-17032 MP	x	x	x	Flaw lead, glaciers, first year ice, grey ice.
1245-13423 MP	x	x	x	Flaw lead, iceberg tongue, multiyear ice, grey ice.
1248-15453 MP	x	x		Refrozen leads, flaw lead, first year ice, grey ice, grey-white ice.
1259-20133 MP	x	x	x	Flaw lead, grey ice, floes.
1301-20465 MP	x	x	x	Flaw lead, clouds, grey ice.
1318-20405 MP	x	x	x	Grey-white ice, floes (multiyear)
1318-20414 MP		x	x	Giant floes, vast floes, clouds.
1322-19223 MP	x			Ridges, puddles, first year ice.
1324-19343 MP	x			Polynya, ridges, floes, open water.
1325-19394 MP	x			Floes, fractures, ridges, puddles, cloud.
1341-19280 MP	x	x	x	Floes, ridges.
1349-20124 MP	x	x		Floes, polynyas.

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

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NASA GSFC
GREENBELT, MD. 20771
301-982-5406

GSFC 37-2 (7/72)

DISCIPLINE: MARINE RESOURCES AND OCEAN SURVEYS, SEA ICE MONITORING

TITLE: EVALUATE THE APPLICATION OF ERTS-A DATA FOR DETECTING AND MAPPING SEA ICE (SR No. 126)

PRINCIPAL INVESTIGATOR: James C. Barnes (PR525)
Environmental Research & Technology, Inc.
429 Marrett Road, Lexington, Massachusetts 02173

DISCUSSION OF SIGNIFICANT RESULTS

The results of the analysis of data collected during the spring and summer of this year demonstrate that ERTS imagery has a high potential for monitoring arctic sea ice conditions during the time of maximum ice extent through the ice-breakup season. In the eastern Beaufort Sea area, the combination of ERTS orbital overlap and a high incidence of cloud-free conditions during the spring assures a high frequency of repetitive satellite coverage. With this repetitive coverage, the deformation and movement of ice features can be mapped throughout the early April to late June period.

In the mid-Beaufort-Sea, numerous fractures and leads can be identified, even in the early spring data. In the easternmost Beaufort Sea, near Prince Patrick and Banks Islands, a quasi-permanent lead can be identified over an extended period, and the growth and eventual deterioration of the lead can be mapped. Ice features that can be identified include the following: the development of fractures leading to the formation of distinct ice floes; the growth and deterioration of leads; evidence of shearing movements of ice masses; the formation of new grey ice within leads; the distinction between grey-, grey-white, and older forms of ice; and the deterioration of the ice surface evidenced by the formation of puddles, thaw holes, and drainage patterns. As was found in analyses performed earlier in the study, ice types can be identified most reliably through analysis of both the visible and near-IR spectral bands.

Ice conditions in the Bering Sea near St. Lawrence Island on two dates in early March reported by aircraft observers participating in the Bering Sea Expedition (BESEX) are in close agreement with the ice conditions mapped from the corresponding ERTS imagery. The ice features identified in ERTS imagery and substantiated by the aerial observer include the locations of boundaries between areas consisting of mostly grey ice and of mostly first and multiyear ice, the existence of shearing leads, and the occurrence of open water with the associated development of stratus cloud streaks.

Examination of aerial photographs taken on the BESEX flights also indicate many ice features that can be identified in the corresponding ERTS imagery. Vast, big, and medium category floes embedded in grey ice can be identified, as can a band of grey ice along the edge of snow-covered fast ice; the grey ice band is as narrow as about 300 feet across.